



Concept Selection Process

***GRNS Meeting: Washington, DC
February 5-6, 2002***

***“How will we choose from the
20 evaluated concepts,
to select the
6-8 recommended concepts
for Gen IV ?”***

- ***Examine how far the evaluations take us***
- ***Identify options for making the selection***
- ***Discuss and agree on the process to be used***

Preview of Options for Making the Selection

Selections could be based upon:

- 1. Evaluations only***
- 2. Evaluations with Non-uniform Weighting***
- 3. A Portfolio of Systems***
- 4. Phased Development and Deployment***

Examine how far the Evaluations take us

- 1. Summarize the evaluations to date***
- 2. Explore sensitivities to major variables, e.g., weights***
- 3. Examine the ‘robustness’ of the selections***

***“We are focused on the process, and
not on the selections, at this point.”***

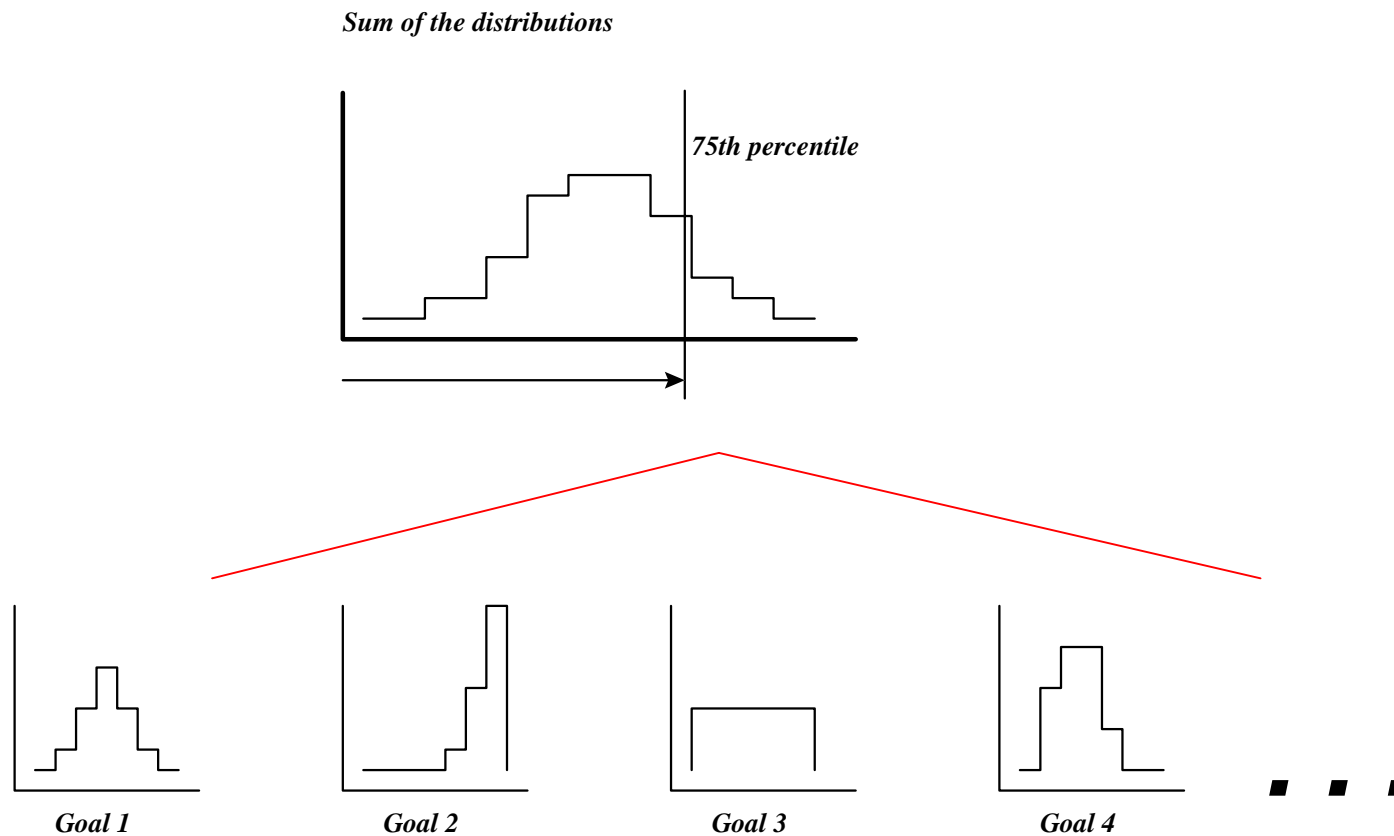
Key Assumptions and Highlights

- ***Summary based on Jan 25th TWG submittals***
- ***Evaluations based on v2 of the FSR***
- ***20 concepts are evaluated***
- ***TWGs and CGs are still actively working on the evaluations (until the end of April)***

***“It is very important to remember that
the evaluations are still preliminary.”***

Definition: Composite Score

The sum of the eight goal evaluations, reported at the 75th percentile of the distribution. A perfect score is 8.



Concept Identifiers in this Presentation

- **Water-cooled systems**

- *W1 - Integral primary system*
- *W2 - Simplified BWR*
- *W3 - CANDU NG*
- *W4 - SCWR, thermal*
- *W5 - SCWR, fast*
- *W6 - High conversion BWR*

- **Gas-cooled systems**

- *G1 - PBR open cycle*
- *G2 - PMR open cycle*
- *G3 - VHTR open cycle*
- *G4 - Generic gas with closed cycle*
- *G5 - Gas fast reactor*

- **Liquid-metal cooled systems**

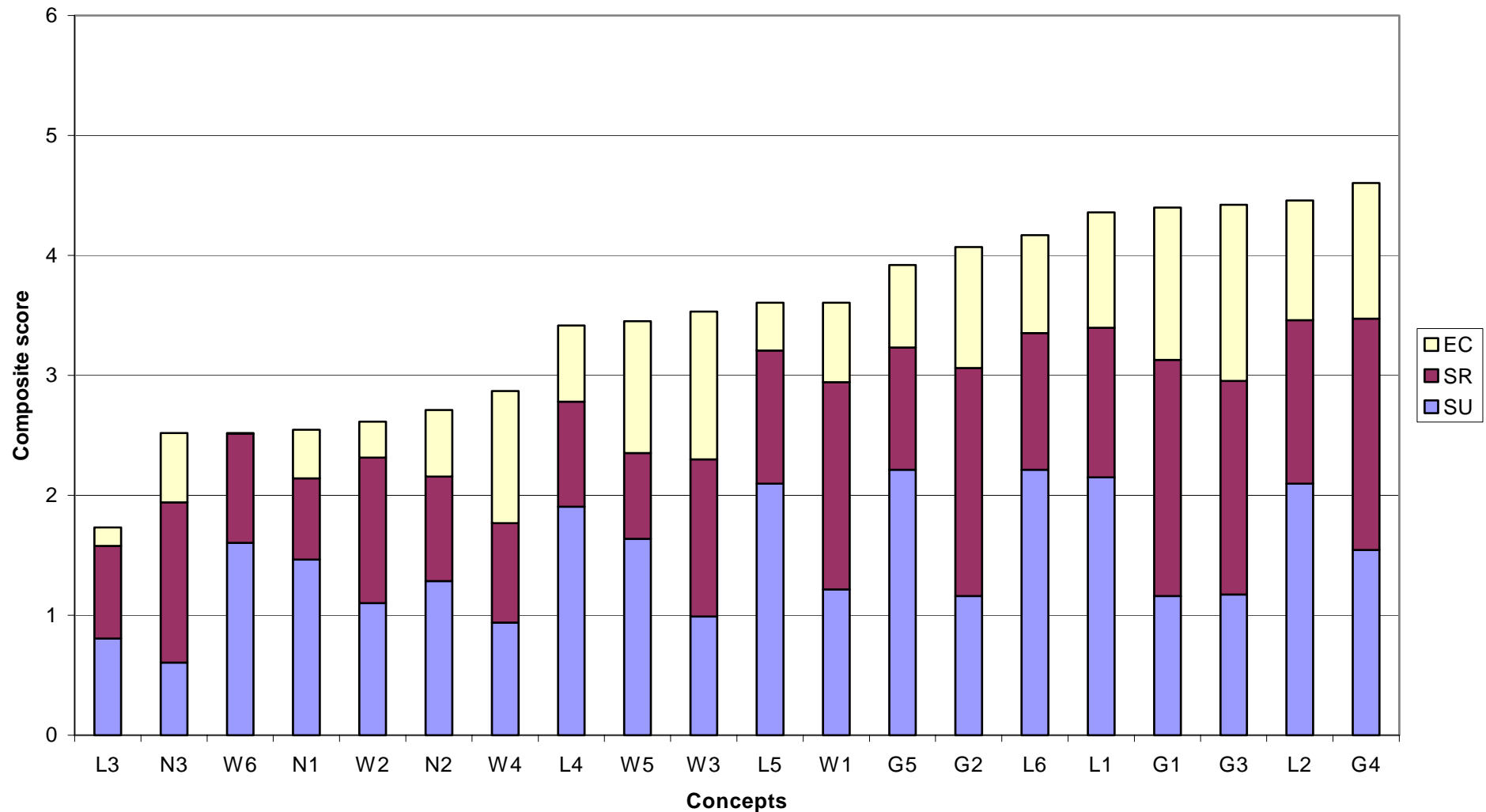
- *L1 - Na cooled, oxide fuel*
- *L2 - Na cooled, metal fuel*
- *L3 - Na cooled, metal fuel, Japan*
- *L4 - Medium Pb/Pb-Bi cooled, US*
- *L5 - Medium Pb/Pb-Bi cooled, Russia*
- *L6 - Small Pb/Pb-Bi cooled*

- **Non-classical systems**

- *N1 - Molten salt core*
- *N2 - Gas core*
- *N3 - Molten salt cooled*

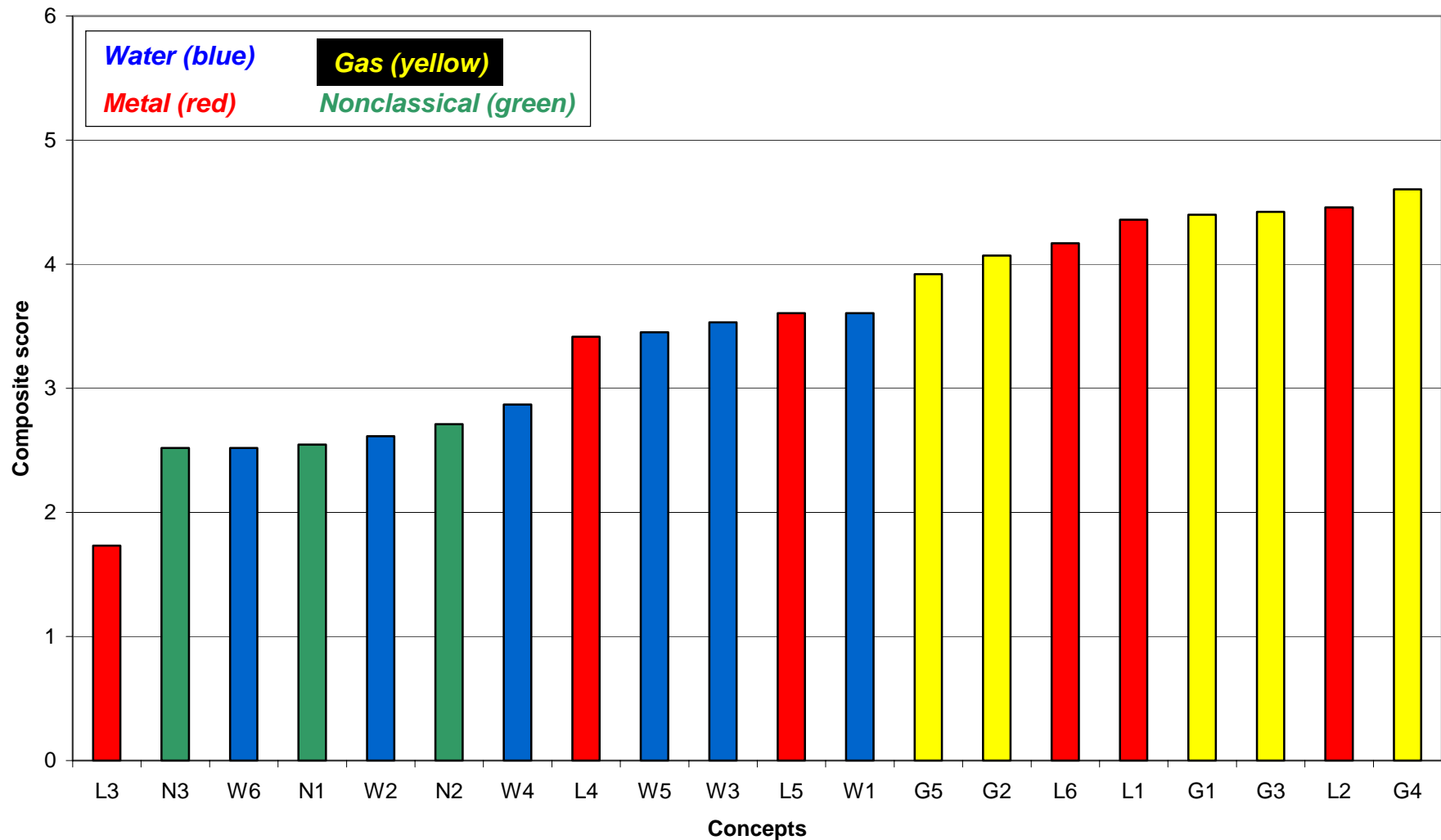
Evaluations showing Goal Area Contributions

75th Percentile Composite Scores
January 25, 2002 Draft Evaluations



Composite Evaluation for all Concepts

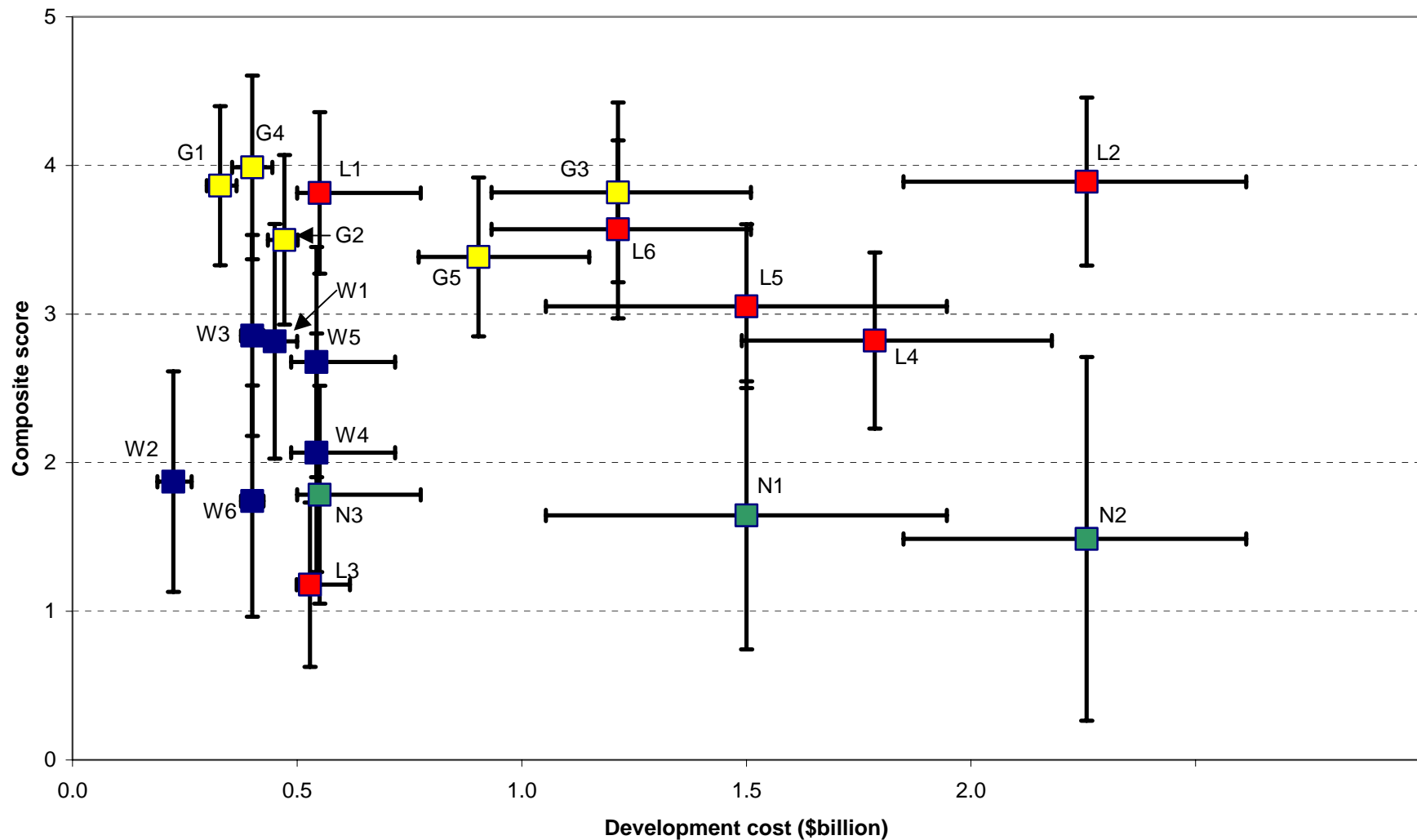
75th Percentile Composite Scores
January 25, 2002 Draft Evaluations



Concept Potential and Development Cost

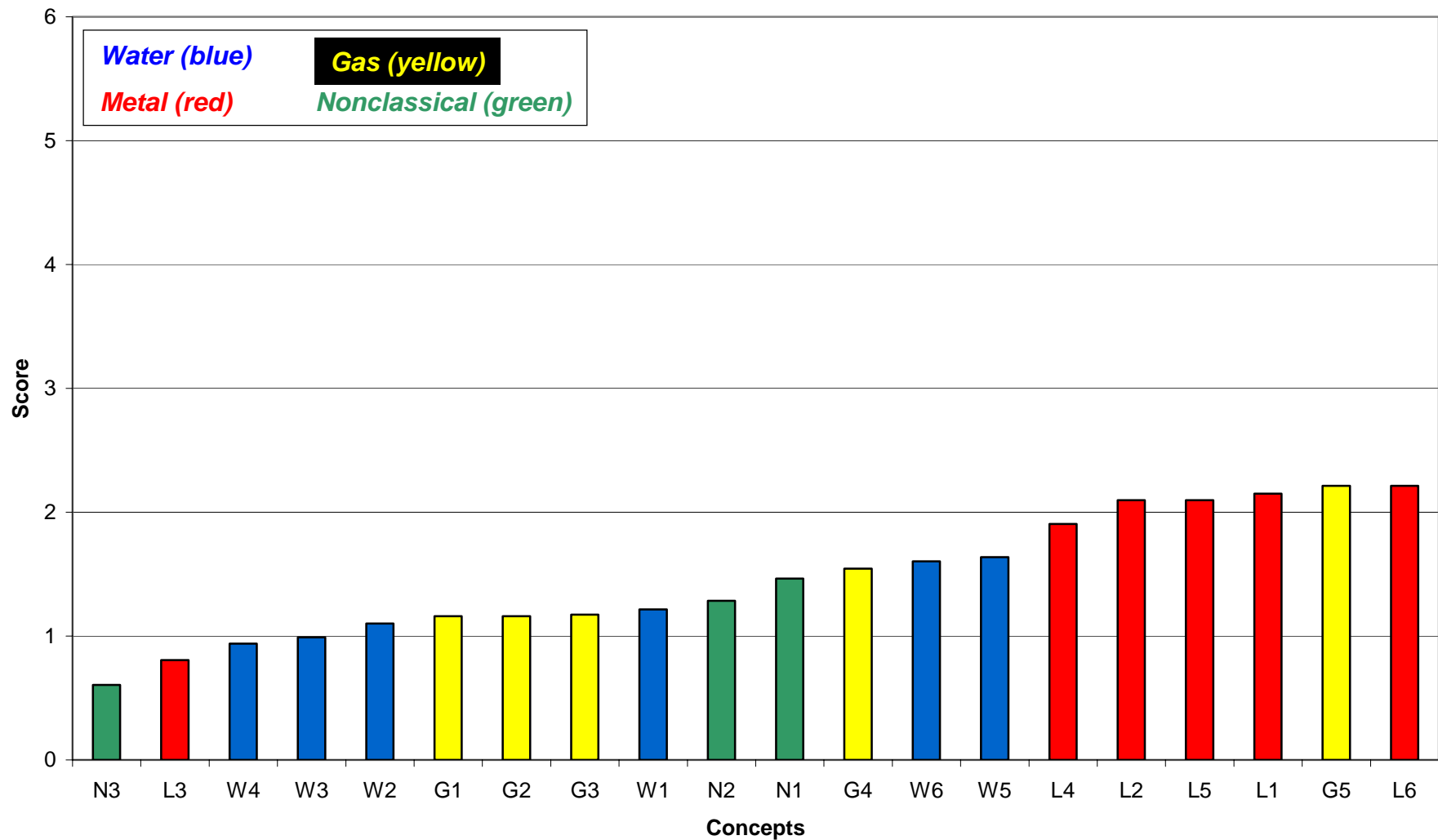
Potential versus Development Cost - 25th, 50th, and 75th Percentiles

January 25, 2002 Draft Evaluations



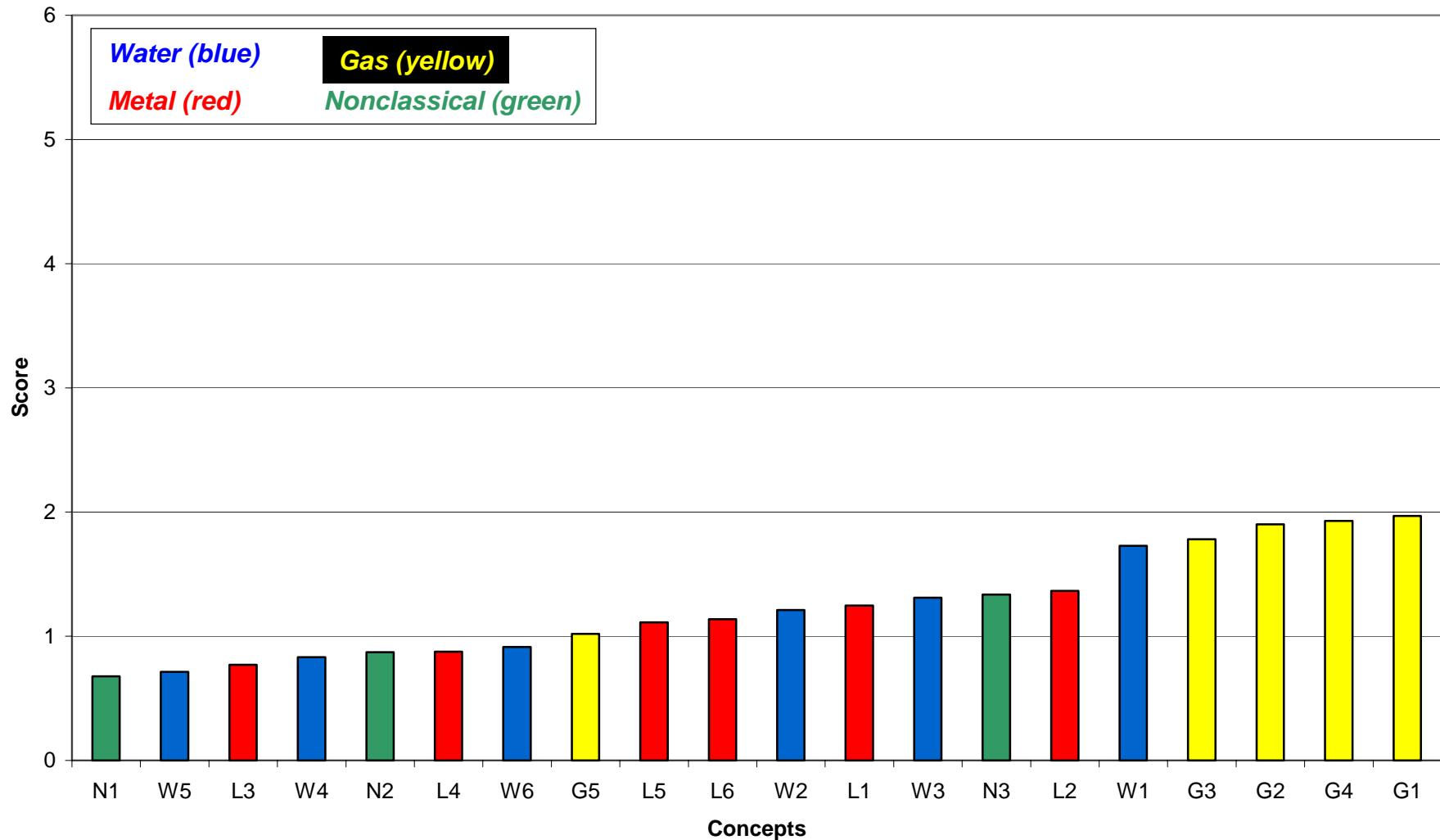
Overall Sustainability Evaluations

Sustainability - 75th Percentile
January 25, 2002 Draft Evaluations



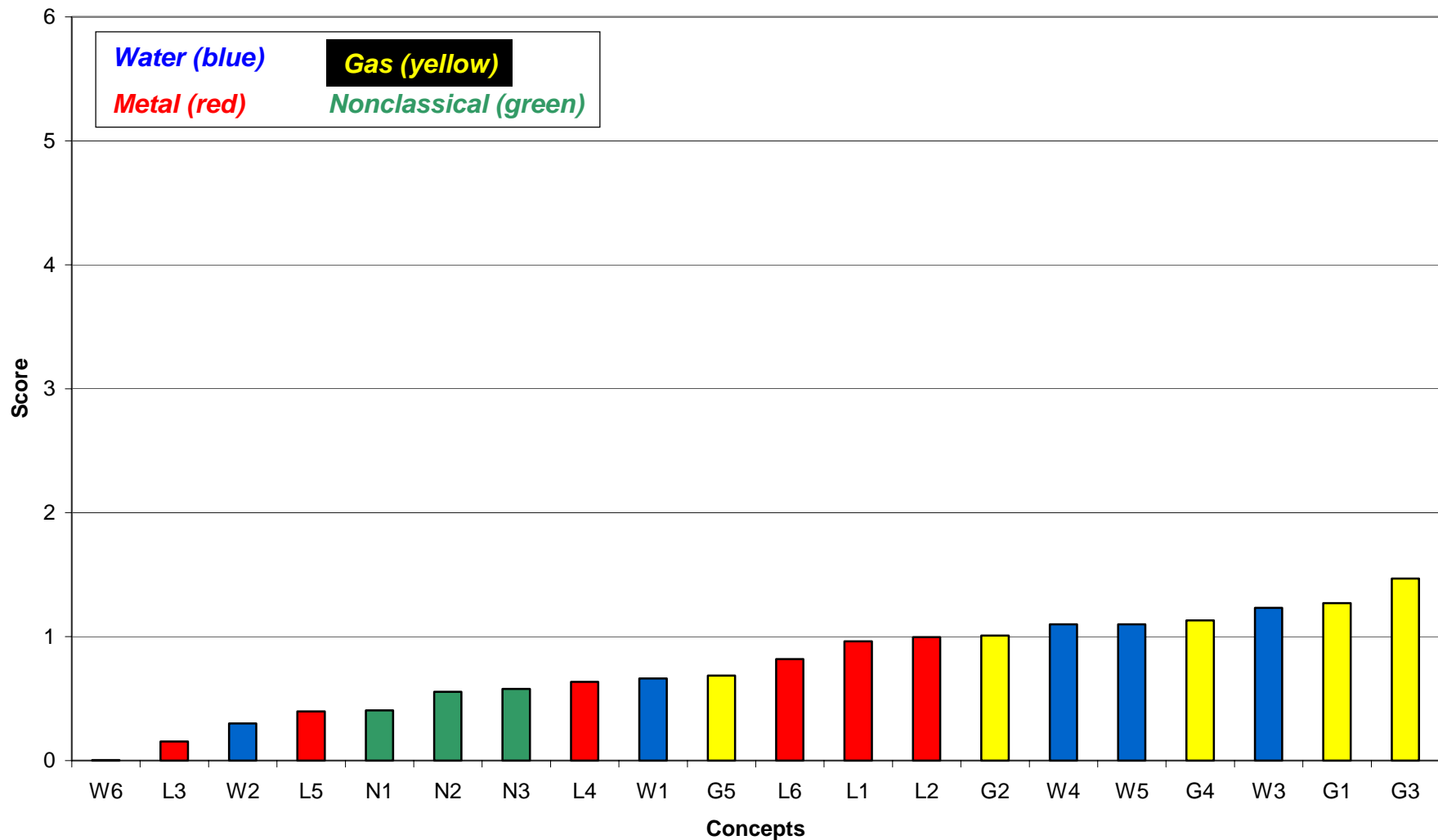
Overall Safety & Reliability Evaluations

Safety & Reliability - 75th Percentile
January 25, 2002 Draft Evaluations



Overall Economics Evaluations

Economics - 75th Percentile
January 25, 2002 Draft Evaluations



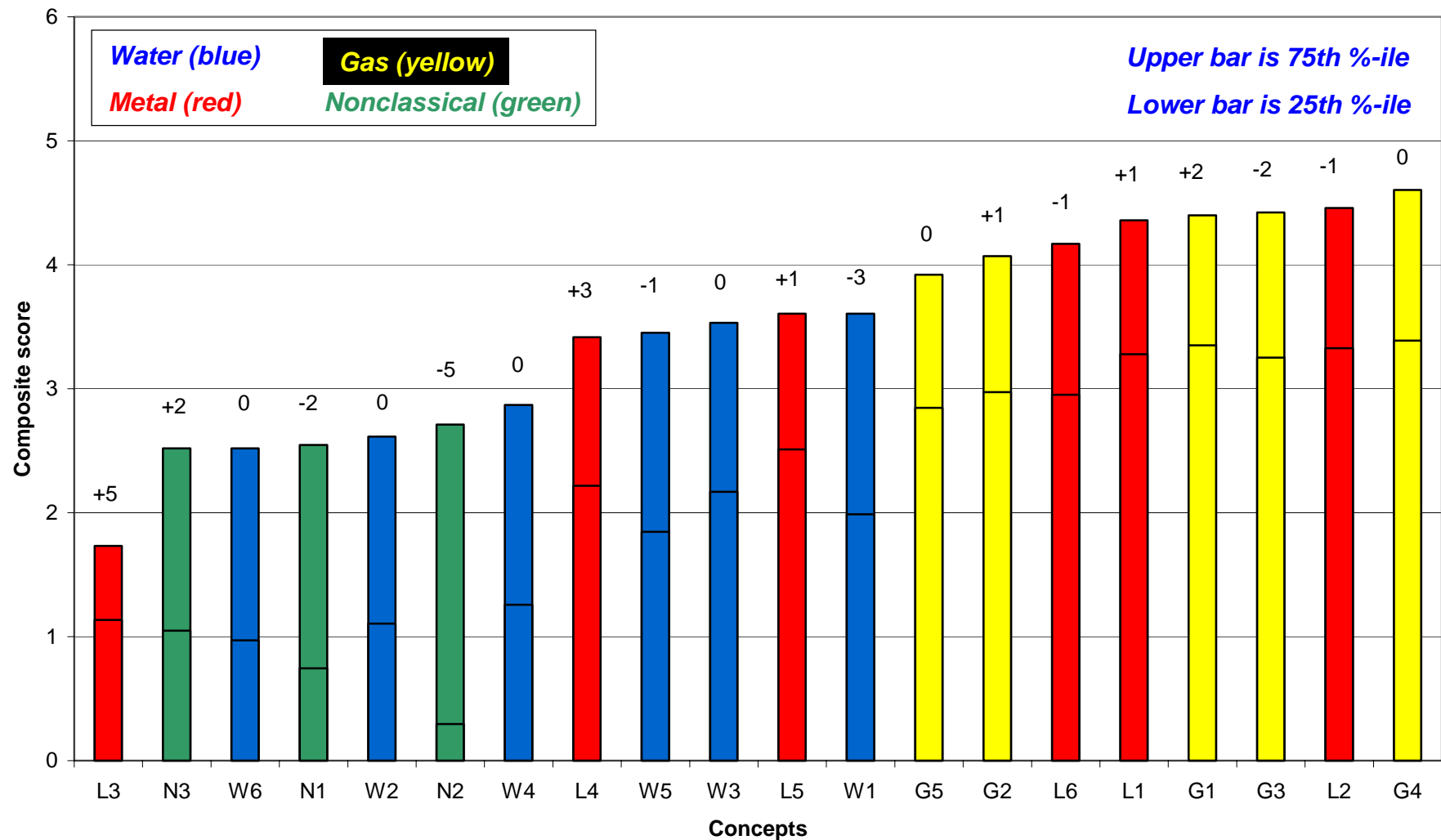
Conclusions on Goal Area Evaluations

- *Evaluations within a group appear to produce consistent ordering of their concepts.*
- *Overall, the evaluations in sustainability seem generally consistent: fast reactors dominate the upper half of the field.*
- *Evaluations in safety and reliability and economics seem generally consistent, although a number of evaluations need further examination.*

“It is important to note that rankings based on composite scores give only part of the picture.”

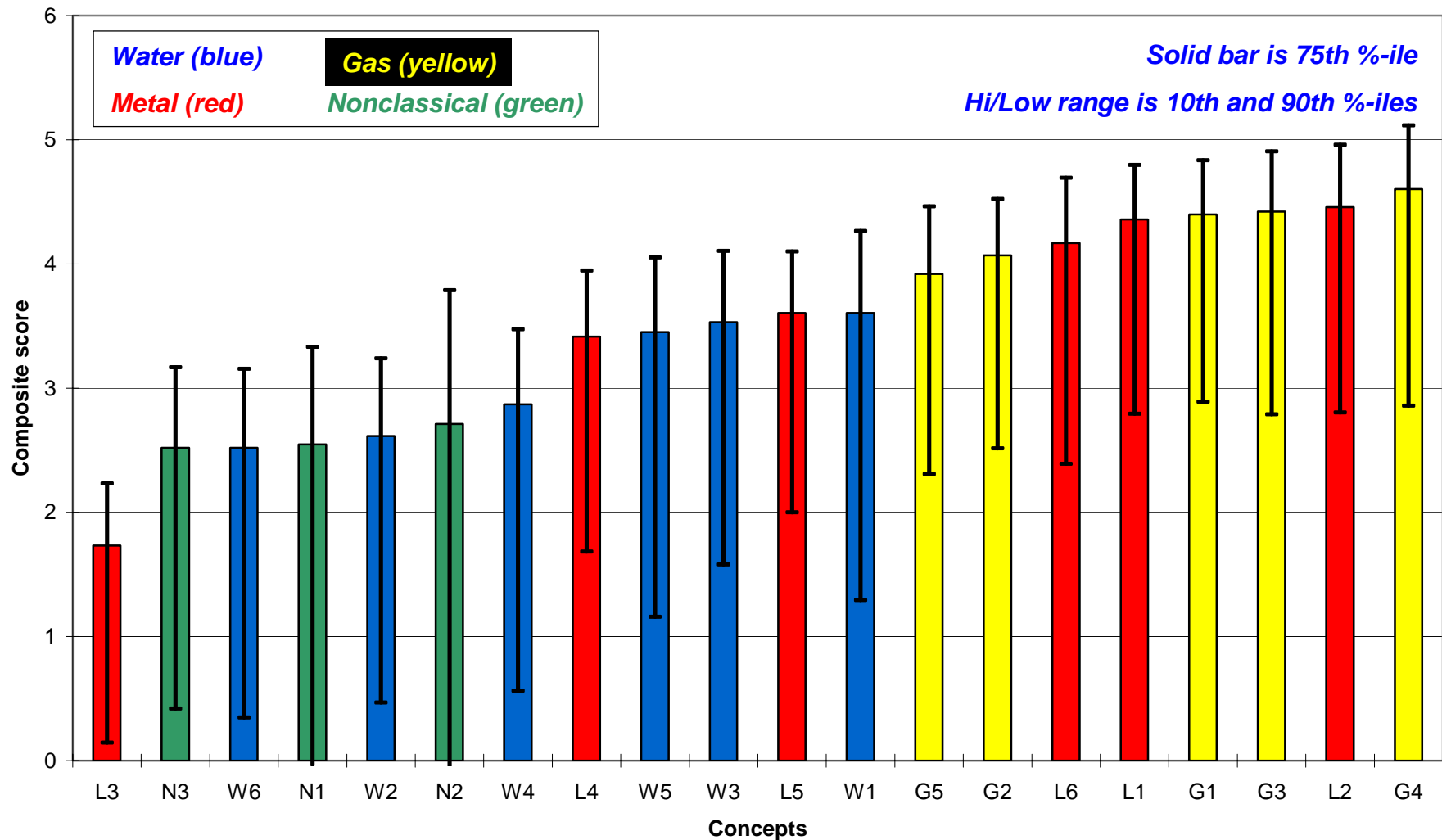
Sensitivity of Composite Evaluations to the Choice of Reporting Percentile

75th and 25th Percentile Composite Scores
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Overall Uncertainty of the Evaluations

Composite Score Ranges - 10th, 75th and 90th Percentiles
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Conclusions on Composite Evaluations

- *Relative rankings are not very sensitive to the choice of reporting at the 75th percentile (recommended by EMG)*
- *The width of the overall distributions (e.g., 25th-75th %-ile ranges) are somewhat larger for the concepts in the lower half of the field. The lowest third seems clearly distinct from the highest third of the field.*
- *The range of variability in potential is fairly large. That is, few, if any, concepts appear to be 'clear' choices.*

“Fundamental issue: Can further refinement of the evaluations be reasonably expected to reduce the range of uncertainty in the evaluations?”

Defining 'Double' and 'Half' Weights for the Goal Area Sensitivity Analysis

Equal-weighting:

$$\begin{aligned}\text{Composite score} = & \text{SU-1} + \text{SU-2} + \text{SU-3} \\ & + \text{SR-1} + \text{SR-2} + \text{SR-3} + \text{EC-1} + \text{EC-2}\end{aligned}$$

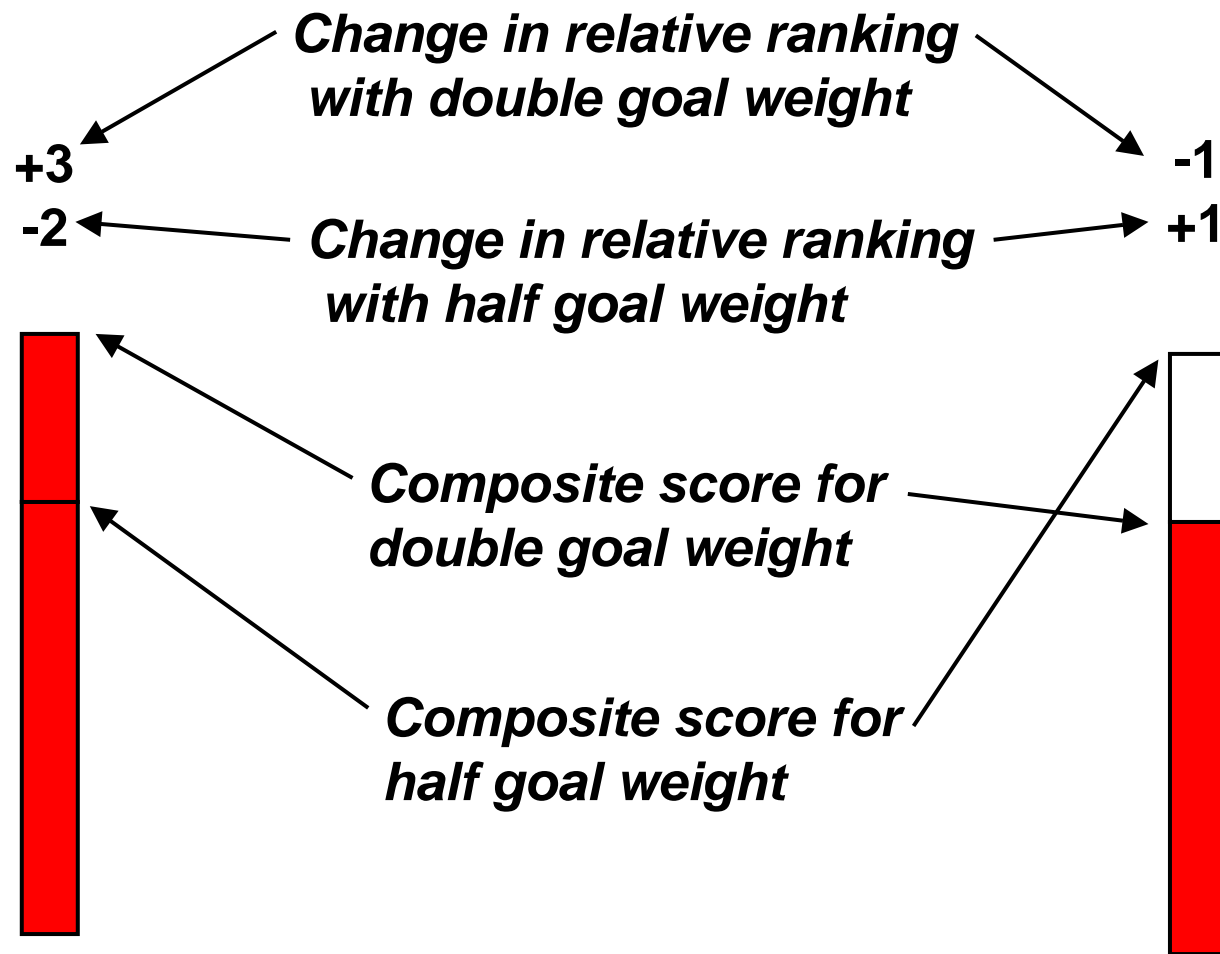
Double-weighting sustainability:

$$\begin{aligned}\text{Composite score} = & 2(\text{SU-1} + \text{SU-2} + \text{SU-3}) \\ & + (\text{SR-1} + \text{SR-2} + \text{SR-3} + \text{EC-1} + \text{EC-2}) \\ & \text{(renormalized to maximum possible score of 8)}\end{aligned}$$

Half-weighting sustainability:

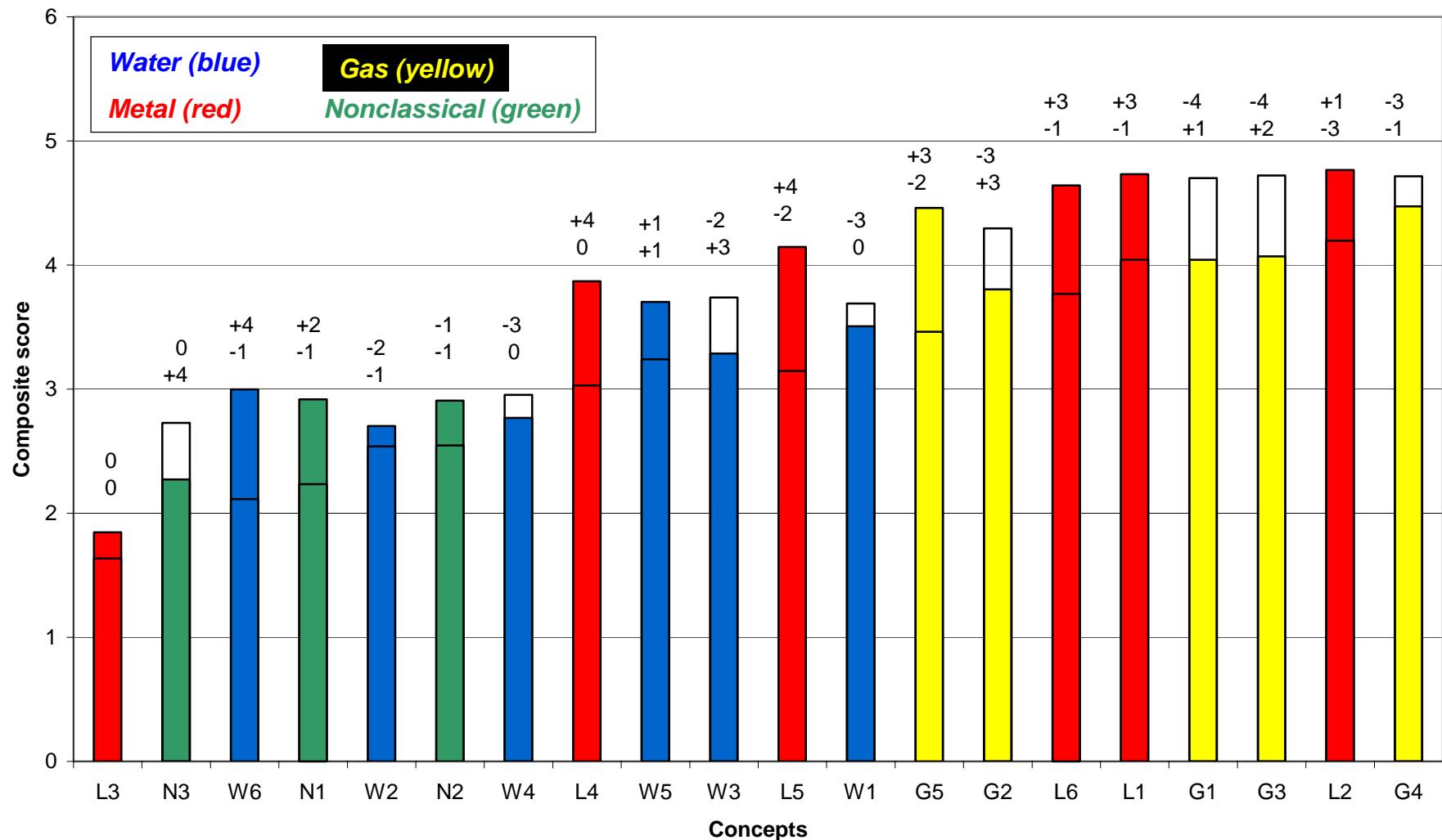
$$\begin{aligned}\text{Composite score} = & 1/2(\text{SU-1} + \text{SU-2} + \text{SU-3}) \\ & + (\text{SR-1} + \text{SR-2} + \text{SR-3} + \text{EC-1} + \text{EC-2}) \\ & \text{(renormalized to maximum possible score of 8)}\end{aligned}$$

Explanation of Labeling on Sensitivity Charts



Composite Evaluations with Double and Half-weighted Sustainability Goal Area

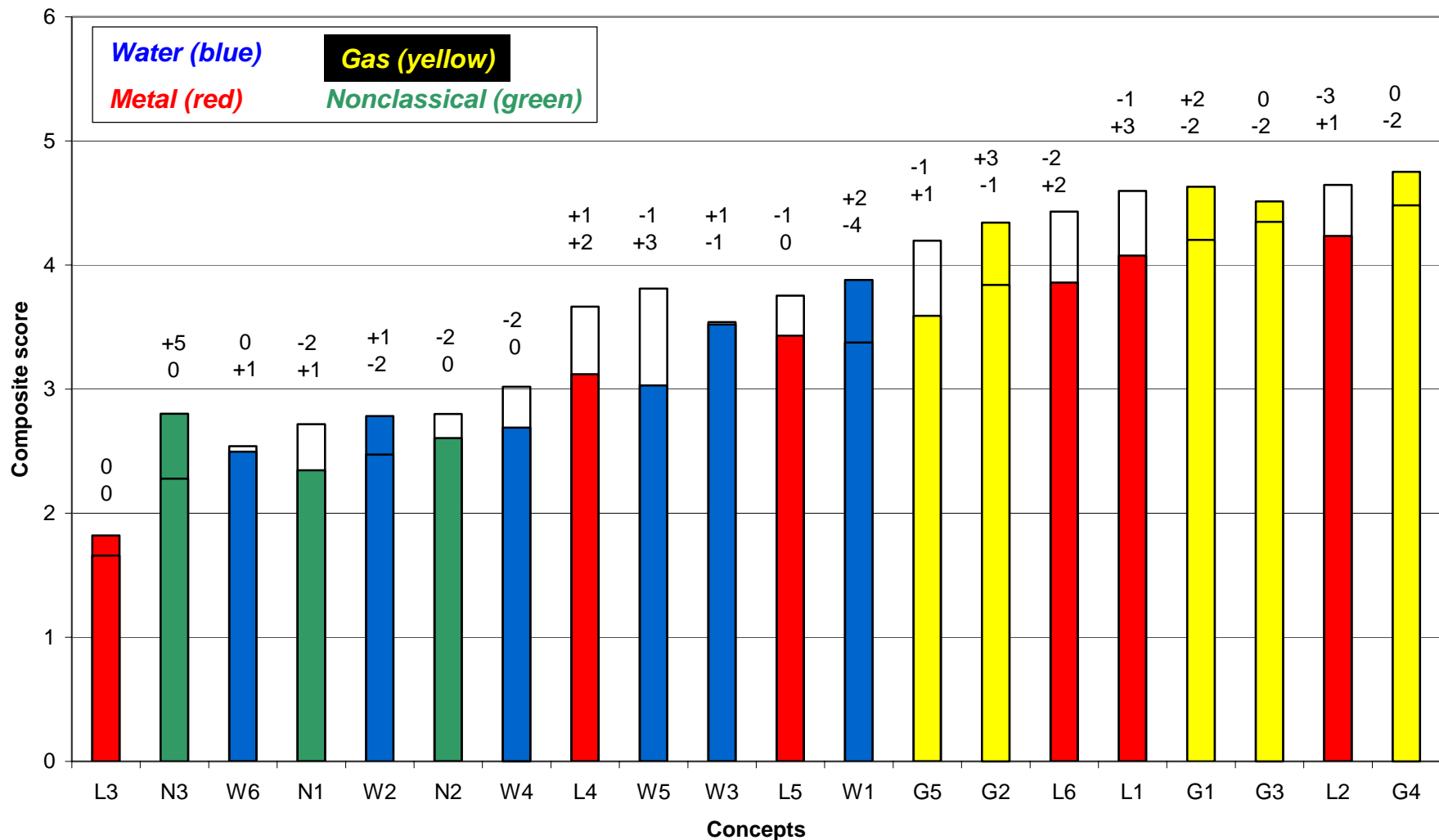
Sustainability Goal Area Sensitivity - 75th Percentile
January 25, 2002 Draft Evaluations



Composite Evaluations with Double and Half-weighted Safety & Reliability Goal Area

Safety & Reliability Goal Area Sensitivity - 75th Percentile

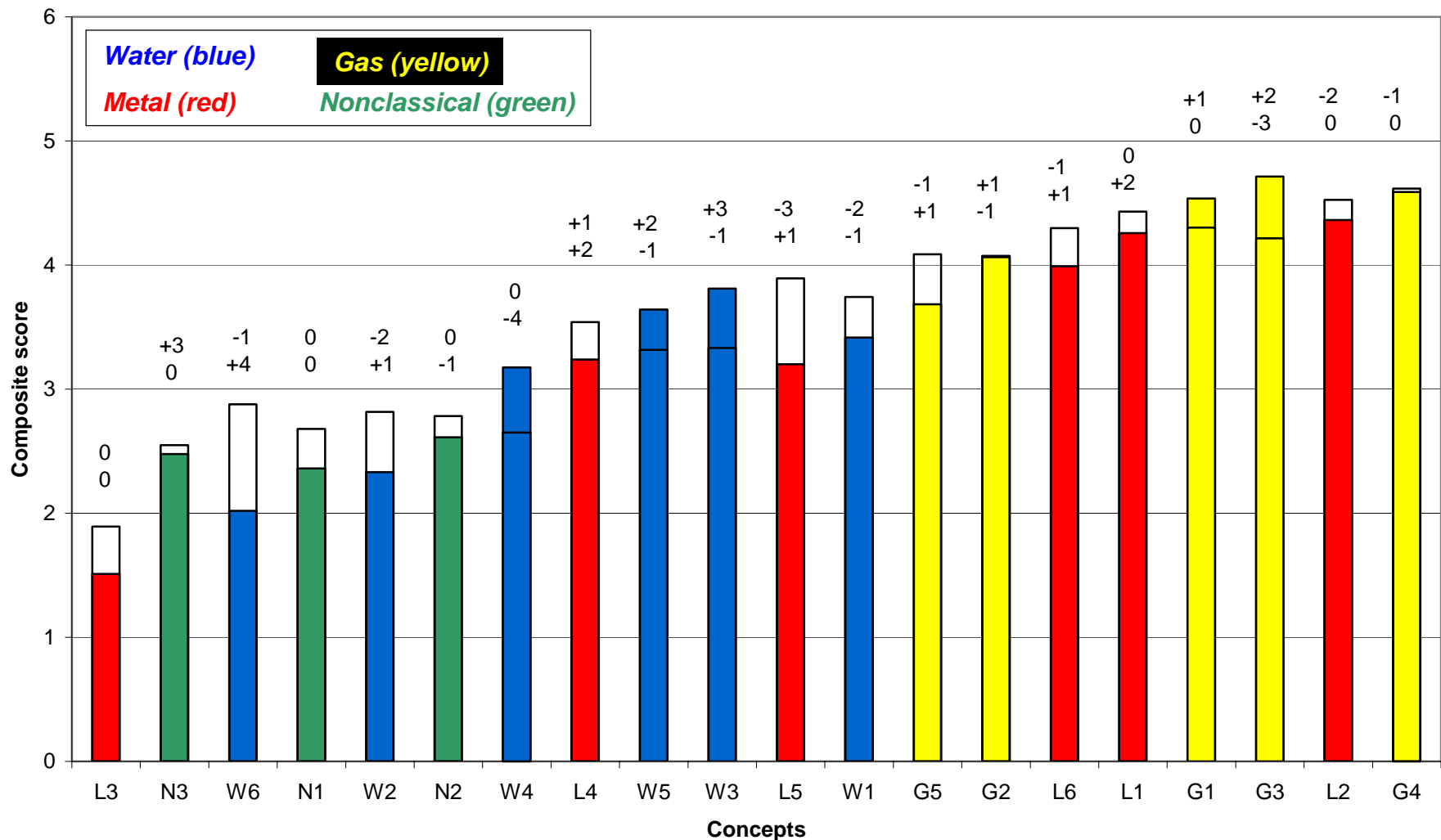
January 25, 2002 Draft Evaluations



Composite Evaluations with Double and Half-weighted Economics Goal Area

Economics Goal Area Sensitivity - 75th Percentile

January 25, 2002 Draft Evaluations



Conclusions on Weighting

- *Variation of the composite score with double or half goal area weighting is large enough to cause some shifts in the rankings. However, it does not yield more than one replacement in the highest third of the field.*
- *Weighting of individual goals has not been explored, but the results are expected to show a somewhat smaller shifting of rankings.*

“Weighting of goals must be very heavy to produce appreciable changes in the field.”

Identify Options for Making the Selection

- 1. Selection based on Evaluations only***
- 2. Selection based on Evaluations with Non-uniform Weighting***
- 3. Selection of a Portfolio of Systems***
- 4. Selection for Phased Development and Deployment***

***“There are many alternatives within these,
and it is possible to combine some of them.”***

Example 1: Selection based on Evaluations only

- *This avoids a judgement of which goals are more important than others*
- ***Example: consider the top 10 concepts in:***
 - ***Composite score, as well as in the***
 - ***SU, SR, and EC evaluations***
- ***Intersect sets to find those concepts that appear in:***
 - ***All four sets***
 - ***Any three of four sets***
- ***Review the selections to assure that none is unacceptable in its weakest evaluation.***

Example 1: Selection Results

- **Concepts that are in the top 10 of all four sets:**
 - **G4 (Generic modular gas with closed cycle)**
 - **L1 (Na cooled, oxide fuel, aqueous reprocessing)**
 - **L2 (Na cooled, metal fuel, pyroprocessing)**

- **Concepts that are in the top 10 in three out of four sets:**
 - **L6 (Small Pb/Pb-Bi cooled)** 11th in SR
 - **G3 (VHTR, open cycle)** 13th in SU
 - **G2 (PMR, open cycle)** 14th in SU
 - **G1 (PBR, open cycle)** 15th in SU

Example 2: Selection based on Weighted Evaluations

- *Agree on relative weights of goals, or goal areas*
- **Example:**
 - *Double the weight of SU-1 and SU-2*
 - *Halve the weight of EC-1 and EC-2*
- *Review the selections to assure that none is unacceptable in its remaining goals.*
For example: “SR evaluations must all be significantly better than Generation III.”

Example 2: Selection Results

	SR
– <i>L2 (Na-cooled, metal fuel, pyroprocessing)</i>	1.4
– <i>L1 (Na-cooled, oxide fuel, aqueous reprocessing)</i>	1.3
– <i>L6 (Small Pb/Pb-Bi cooled)</i>	1.2
– <i>G4 (Generic modular gas with closed cycle)</i>	1.9
– <i>G5 (Gas fast reactor with closed cycle)</i>	1.0
– <i>L5 (Medium Pb/Pb-Bi cooled, Russia)</i>	1.2
– <i>L4 (Medium Pb/Pb-Bi cooled, US)</i>	0.9
– <i>G3 (Very high temperature gas with open cycle)</i>	1.8

Example 3: Selection of a Portfolio

- *This attempts to reduce risks from future uncertainties by being prepared on a variety of fronts*
- *Identify probable/possible market scenarios*
- *Identify those concepts that are relevant to each scenario (i.e., 'bin' them, and note that a concept may appear in more than one bin.) This may require extending the evaluation into additional areas.*
- *Select the best concept(s) in each scenario, based on the evaluation of potential.*

Example 3: Selection Results

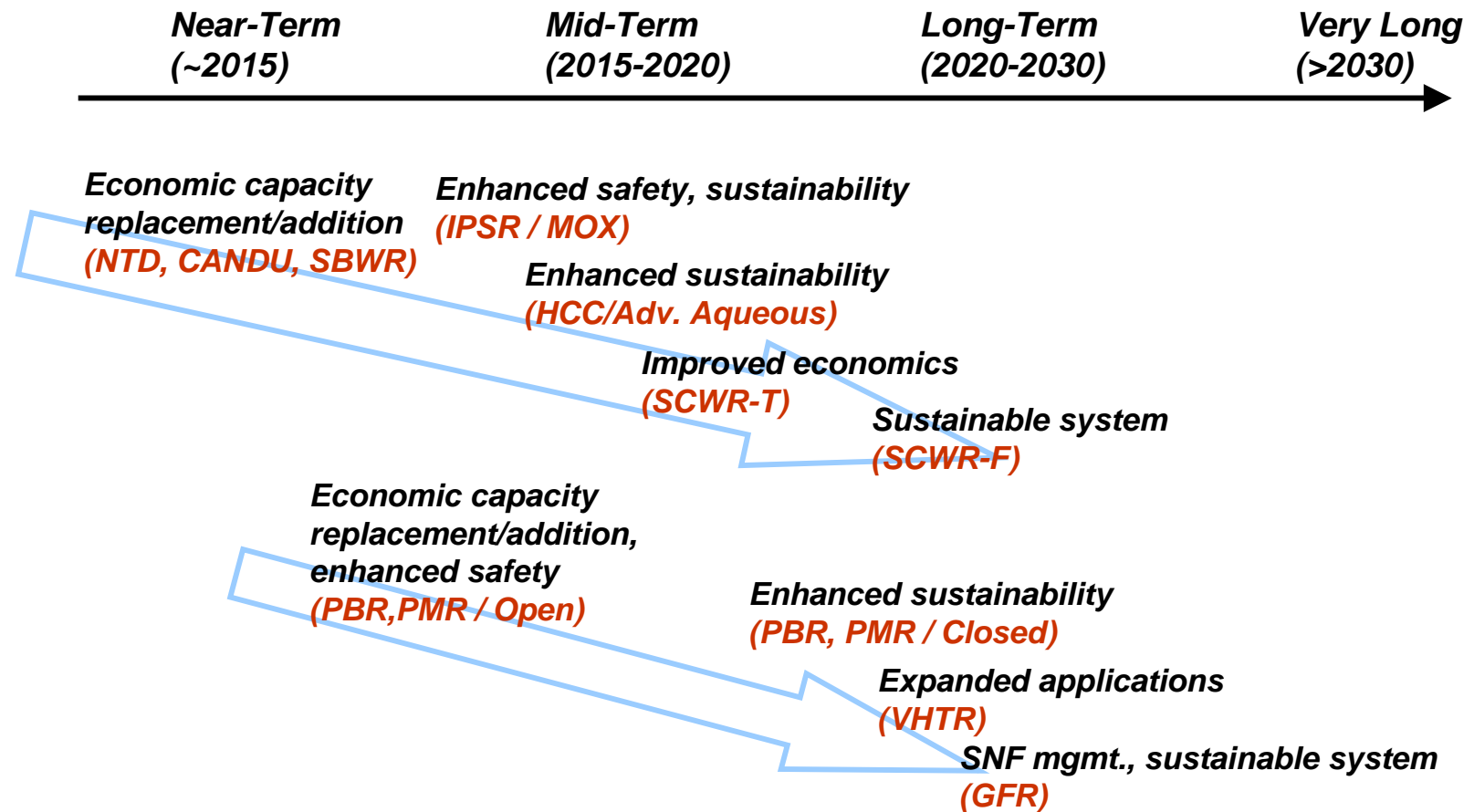
- *Very economical electricity, large grid*
 - *further analysis: probably water systems*
- *High recycle for waste reduction with current systems*
 - *further analysis: fast reactors with high recycle*
- *Hydrogen producers*
 - *further analysis: gas systems*
- *Reliable electricity, small grid*
 - *further analysis: modular systems*
- *High inherent safety*
 - *further analysis: probably gas systems*

Example 4: Selection for a Phased Development and Deployment

- *This attempts to let the desired long-term systems enjoy the technology advances of nearer-term systems*
- *Evaluate where candidates stand with respect to their near- or long-term deployment*
- *Select the most promising long-term candidates, possibly from a portfolio standpoint*
- *Map the development pathways to show the relationship of systems that will (or could) be developed earlier*
- *Then select additional systems that will support the development pathway*

Example 4: Selection Results

- Endpoint: High recycle systems for waste reduction



Conclusions

- *Evaluations to date have been presented with the aim of understanding their quality and general trends.*
- *Through the efforts of the TWGs, the evaluations are progressively being refined and made consistent.*
- *The evaluations, by themselves, are not definitive on the selections. The evaluations, however, are useful for informing the process of selection.*
- *Four options (with preliminary examples) have been identified for making choices for Generation IV. Many other options exist.*
- *The examples presented have considerable similarity in their results: while they won't necessarily converge to a unique selection, they offer some hope for the robustness of the selections.*